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CONSERVATION OF BIOLOGICAL DIVERSITY

BACKGROUND AND ISSUES

Report of the Secretary-General of the Conference

INTRODUCTION

1. At its second substantive session, the Preparatory Committee requested the Secretary-General of the Conference to take due account of decision 2/9 and to elaborate on the conservation of biological diversity for discussion at the third session. The UNCED secretariat acknowledges the contributions from the Working Party on Biodiversity which met in Rome, 29 and 30 April, 1991, as well as inputs received from other experts in preparing and reviewing this report.

2. The Secretariat has given careful consideration to the relevant passages of the regional declarations in developing "Options for Agenda 21" for the "Conservation of Biological Diversity" as outlined in document A/Conf.151/PC/42/Add.4. These options address the need to ascertain the full extent of the earth's biological diversity (biodiversity) in a concerted and

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systematic way; the need to develop economic and other techniques for integrating biodiversity concerns fully into the decision-making process at all levels; the need to strengthen new approaches for conserving biodiversity; and the need to improve awareness-raising, education and training and to provide for building up institutional capacities, especially in the developing countries.

3. Following decision 16/42 of the Governing Council of UNEP at its sixteenth session (May, 1991), the "Intergovernmental Negotiating Committee for a Convention on Biological Diversity" met in Madrid 24 June to 3 July 1991. The meeting considered a revised draft of the Convention, prepared following the Ad Hoc Working Group of Legal and Technical Experts in Nairobi 25 February to 6 March 1991. The draft was based, inter alia, on the discussions of a regionally balanced group of senior legal advisors who were present at the second session and who met in Geneva from 11 to 13 April 1991.

4. As stated in paragraph 2 above, this report also takes account of the relevant paragraphs of the Bergen Ministerial Declaration on Sustainable Development, the Tlatelolco Platform on Environment and Development, the Ministerial Declaration on Environmentally Sound and Sustainable Development in Asia and the Pacific, as well as the results of the Regional Conference for Africa.

STATE OF KNOWLEDGE ON BIODIVERSITY

5. The rich diversity of genes, species, populations, and ecosystems on our planet provides an abundant and essential supply of indispensable goods and services. They constitute the basis of our sustenance, providing all our food and fiber needs, and many of our medicines. Some of this biodiversity grows in farmers' fields, most of the rest is found in forests, savannahs, deserts, tundras, and the seas. A small amount is in genebanks, botanical gardens, and zoos.

6. Diversity is constantly changing. New genes arise out of mutation, and old ones are eliminated by selection. New species arise by the normal processes of evolution, and old ones go extinct for a variety of reasons. Farmers and breeders develop new crops, and give up growing old ones. Lately, human activities have increased significantly the rate of loss of biodiversity, but not much has been done, or can be done, to increase the rate of generation of new diversity. The result is loss of biodiversity. By losing biodiversity, we lose options for future development, especially of new and more productive food crops and medicines.

7. Micro-organisms and animal wildlife are a crucial component of biodiversity, especially invertebrates. They play an essential role in natural ecosystems, helping in the circulation of nutrients, and effecting their decomposition and mineralization. Birds and insects play an irreplaceable role in the pollination of plants; many birds and mammals play a similar role in seed dispersal. Hunting wild biomass, especially of vertebrates, has provided the genetic stock for our domesticated animals. Skins, hair, feathers, tusks, horns, and other wild animal products are a major source of income for people in many countries. Finally, plant and animal diversity is a major attraction for tourism.

8. The natural ecosystems all over the world have been transformed by humans at increasing rates since the invention of agriculture 10,000 years ago. The rate of transformation has been particularly intense since the industrial revolution and the rapid rate of growth of the human population that followed. Ecosystem transformation carries with it the threat of a potential loss of biodiversity, although the precise relation between landscape transformation and biodiversity loss is unknown. Although it is not known what the exact negative consequences of losing biodiversity are, there is apprehension that the consequences of biodiversity loss may be grave. The loss of genes and species can not be recovered.

9. Population pressures will continue to exert important impacts on the diversity of biological resources. The increasing demand for basic needs requires a more efficient and effective use of our environments. As a result, more untouched ecosystems will be used to address these needs, either at sustainable levels or at over-exploitative levels. Biodiversity may therefore diminish. The challenge is to find ways to permit development of natural resources without threatening their integrity and diversity excessively. For that we must first learn how much biodiversity is present, what its role is in the function of species, populations, and ecosystems, and what its potential economic value is. Ways must be developed to preserve biodiversity while permitting agricultural, forestry, and fisheries development. Since the rate of transformation is rapid, and the potential loss of biodiversity is high, time is of the essence.

10. There is much scientific uncertainty regarding the number of species which inhabit the earth. The information is quite accurate for certain groups (ie. vertebrates, especially mammals and birds) and very poor for others (ie. nematodes and viruses). Knowledge of the genetic diversity of wild species, including that of relatives of economically important plants is even poorer. One serious problem is the lack of knowledge regarding the total number of species. It has been suggested that there may be as many as 100 million life forms on the earth, ranging from the largest mammals to the tiniest micro-organisms. The scientific consensus is that the actual number is of the order of 10 million. 1/ So far, approximately 1.4 million species of plants, animals, and micro-organisms have been described. However, many new species are discovered and described daily, so this figure is an underestimation. The geographical distribution of biodiversity is uneven, with about two-thirds of all terrestrial species being found ~~in the tropics~~. 2/

11. Wet ecosystems, especially tropical forests, harbor many more species than dry and cold areas, but that is not to say that they are any less important. In spite of being in the temperate zone and having a pronounced dry season, Mediterranean-type ecosystems are among the most diverse in the world. Temperate regions, especially in the northern hemisphere, are much better studied than tropical regions, but major gaps remain in existing capacities for measuring, recording, and monitoring biodiversity at the global level to help key decision-makers to evaluate the full economic, social, and environmental potential of biological resources.

12. Organisms from marine environments, both temperate and tropical, are probably the least known of all. Until relatively recently, for example, the deep sea was believed to be without life. Today it is known that it possesses

an abundance of biological resources with more than 800 known species. Ocean hydrothermal vents, such as the sulfide chimneys called "black smokers", contain at least 16 new families of invertebrates that were unknown five years ago. Also recently, an entirely new set of organisms called "picoplankton" were discovered. The productivity of marine systems may have been underestimated by one-half due to ignorance of the role played by this picoplankton and the lack of appropriate methods of measurement. 3/

13. Even where data or genetic materials are collected for scientific purposes, they are all too frequently incomplete or badly managed. For example, there are currently about 3.3 million seed samples of species and their wild relatives in about 750 genebanks around the world. 4/ However, many are poorly equipped, managed and maintained, and some do not follow established genebank standards. Lack of adequate financing is an important problem for genebanks, as well as a symptom that the problem of conservation is not adequately addressed at the societal level. As a result, it is possible that as much biodiversity is being lost in these genebanks as in the field. Some collections have already been lost completely and many of the most important collections of crops are stored under conditions inadequate to ensure their long-term survival or full usefulness.

14. In the wild, the loss of tropical forests is not only reducing the populations of many species very significantly. It is estimated that reducing the size of a habitat by 90 per cent will reduce the number of species which it can be support by about 50 per cent in the long run. 5/ Species richness tends to increase from the poles to the equator and some parts of the planet are more important than others for maintaining the genetic diversity of crops. The loss of biodiversity can therefore have far-reaching implications even before scientists discover how ecosystems function. However, because no systematic comprehensive global monitoring system is in place and much of the necessary baseline information is not known, it is extremely difficult to estimate future - or even current - rates of loss.

15. A number of monitoring systems are in place or are planned. For example, under its GEMS programme, UNEP provides support to the World Conservation Monitoring Centre in its effort to monitor threatened and endangered species. IUBS/SCOPE/ and MAB/UNESCO, in collaboration with UNEP and the International Geosphere/Biosphere Programme are currently in the process of developing a global system for the study and monitoring of biodiversity and the role of ecosystem function. FAO and IBPGR are also currently in the process of developing a Global Information System and Early Warning System on Plant and Animal Genetic Resources to provide information and a practical inventory of genetic resources (both in situ and ex situ) and on the potential hazards threatening global extinction of species and breeds, with a periodical report on the state of the World's Plant Genetic Resources.

16. The FAO Global Animal Genetic Data Bank at Hanover already provides information on the world's livestock breeds. In addition, FAO is in the process of establishing an international network of ex situ base collections of biological resources, and has embarked on developing a network of in situ conservation areas. A global system for the security of the world's plant genetic resources is also beginning to take shape, but the existing

institutional capacity, structures and programmes are generally inadequate and under-funded. Current gaps and weaknesses need to be remedied if the system is to cope with the urgency of the situation.

17. Based on current systems and on traditional taxonomic approaches, it is likely to take several centuries to complete a comprehensive global survey of biodiversity. Efforts therefore need to be made to obtain an accurate assessment of the world's biodiversity prior to the completion of a more careful study. A truly comprehensive global system needs to be established, building on existing programmes, to enable changes in the distribution and state of biodiversity. This implies that there should be a global network of observation sites where work can be undertaken in a coordinated and cooperative manner, taking account of the significant differences between ex situ and in situ approaches.

CURRENT STATUS OF PROTECTION AND CONSERVATION

18. Protected areas probably provide the best mechanism so far devised for conserving biodiversity. To date, more than 130 nations have together established some 6,900 major, legally protected areas, covering almost five per cent of the planet's land surface (roughly twice the size of India). Since 1972, the total number of protected areas has almost doubled and the area protected has increased by over 60 per cent, with an even distribution over the different categories of protected areas. 6/ However, it appears that the rate of increase has begun to slow, and the options for additional protected areas - especially in the more strictly protected categories - seem to be closing in the face of competition from other forms of land use. This is frequently a result of population pressures and unsustainable development, with the five per cent looking less and less adequate.

19. Moreover, the level of legal protection for the 6,900 areas - and the enforcement mechanisms available to support protection - can vary significantly. As development has accelerated in recent decades, the growing importance of legally-protected areas as part of the overall pattern of land use has increasingly been recognized, as well as being the primary means for conserving the full range of wild biodiversity. Such sites maintain the essential ecological processes that depend on natural ecosystems. They also preserve the diversity of species and the genetic variation within them, as well as maintaining the productive capacities of ecosystems, safeguarding habitats critical for the sustainable use of biological resources, protecting landscapes and wildlife, providing opportunities for scientific research, education, training, recreation, and tourism, and serving as sources of national pride and human inspiration. All too frequently, however, in situ conservation efforts are perceived by local communities as a threat to their economic survival. Difficulties can also arise with government agencies, through inadequate management, uncertain and insufficient funding, and weak national constituencies.

20. Nevertheless, the value of protected areas seems likely to increase in the future. They make important contributions to maintaining the genetic raw materials for use in biotechnology, are likely to be central in programmes designed to adapt to changes in climate, and to the sustainable forms of

forestry envisaged in discussions about a possible new international consensus on forests. They also contribute to the development of ecologically sustainable fisheries and agriculture. However, recent advances in conservation have demonstrated that by themselves the strictly-protected categories will not be able to conserve all, or even most, biological resources and ecological processes. One possible response to this dilemma might be to design regional institutions and processes for large watersheds or bio-regions which cut across territorial and sectoral jurisdictions. They ought to be collaborative and participatory, translate sustainability into practical objectives, and take socio-economic as well as environmental factors into account. Such ecoregions, incorporating different categories of protected areas, agriculture, forestry, grazing, research, and education, would be managed so as to maintain the optimum levels of biodiversity.

BIOLOGICAL RESOURCES FOR MEETING HUMAN DEVELOPMENT NEEDS

21. Wild species and the genetic variations within them have an enormous potential for meeting human needs. One of the great achievements of humankind has been the harmonious exploitation of plant and animal resources through agriculture, forestry and fishery activities. Since the dawn of agriculture some 10,000 years ago, crops have been developed, modified and adapted to a wide range of new environments. The original diversity allowed some crops to spread globally and to adapt to environments very different from their original habitats. Rice is now farmed from sea level to high altitudes and wheat is grown in climatic conditions ranging from hot dry plains to humid and cool regions.

22. Traditional farming techniques tend to preserve biodiversity. Traditional Andean farmers in Bolivia may plant more than 30 different potato varieties in their fields. Some are drought resistant, other are especially adapted to wet periods. Some are good for eating fresh and others keep very well. This way farmers are excellent breeders, and they constantly improve their crops, developing new varieties, and dropping others, as circumstances warrant, but always keeping a large stock. By using traditional breeding methods, insights derived from genetics, and plant physiology, modern plant breeders have been able to increase the rate of production of new crop varieties, and increase dramatically their yields.

23. Some striking results have been obtained. China increased rice production substantially by developing hybrid rice using a male sterile strain collected from Hainan Island. Access to a wide range of genetic variability enhanced the capacity of plant breeders for developing new strains possessing a combination of desirable characteristics. These new varieties helped to keep food production above the rate of population growth in most parts of the world, as well as to halt the conversion of more forested land to cropland. Farmers in India, for example, over the period 1965 to 1990, saw a 360 per cent increase in wheat yield with only a 65 percent increase in cropland. 7/ Much more could be expected if some material existing in genebanks could be returned to farmers through extension services and after sanitation. Hybrid rigor could also be exploited in more crops than presently done; technical knowledge and genetic stocks exist to exploit it. Many

genebanks have material on which studies indicate that they can provide within a very short time solutions to stop soil erosion and degradation, as well as alternatives to many contaminants and losses of biodiversity.

24. Mechanization, fertilizers, irrigation and chemical control of pests and diseases have reduced the need to utilize genetic variability. Modern plant varieties became increasingly uniform and spread over ever-larger geographical areas because of their tolerance to day length and temperature. In the process, biodiversity has been reduced. Emphasis needs to be placed on raising yield potential and more efficient use of inputs.

25. The challenge now is to reconcile the short-term imperative of increased food production with the long-term imperative to conserve genetic resources to sustain future food supplies. The Stockholm Conference on the Human Environment in 1972 underlined the critical significance of plant and animal genetic resources to global food security, as well as to the security of the livelihoods of million of rural families. The urgency of the challenge has now increased significantly. The ability of agriculture to respond to this need might depend heavily on actions taken now to preserve its inheritance of biodiversity.

26. The economic value of the contribution made by biological and genetic resources to agriculture, pharmacology and industry amounts to many billions of dollars per annum. One study, for example, estimated that about 4.5 per cent of GDP in the USA is attributable to the harvest of wild species, amounting to an average of $US 87 billion per year in the late 1970s. 8/ Information is also gradually accumulating on the economic benefits to be derived from using biodiversity in the form of genetic resources to improve crop production and animal husbandry by conventional breeding. In 1983, FAO established the Global System for the Conservation and Utilization of Plant Genetic Resources (PGR), which includes a non-binding legal framework (the International Undertaking on PGR) and an Intergovernmental forum (the Commission on PGR). To date, 128 countries are formally part of the Global System. The Commission has recognized the rights of the countries which provide their genetic diversity to be compensated through the concept of farmers' rights. This concept will be given practical meaning through an international funding mechanism to support a global plan of action to be developed during the IV International Technical Conference on PGR to be hosted by FAO in 1993. The Commission has also developed an International Code of Conduct for the collection and transfer of plant genetic resources.

27. The economic and other values of biological resources are nevertheless all too frequently poorly defined. They are frequently underestimated because only short-term commercial market values are taken into account. While it is difficult to quantify some aspects of the value of biodiversity, much can nevertheless be done to assess the value of commercially-harvested products such as timber, fish, and medicinal plants. Field research can also be used to ascribe values to natural products such as game meat and non-timber forest products which are consumed directly, often without passing through the marketplace. The indirect values of ecosystem functions, such as watershed protection, tourism, soil conservation and climate regulation are harder to quantify, but approximate estimates can be made and they will certainly be more accurate than current de facto values (i.e. zero, in most cases).

28. Tourism, one of the world's largest industries in terms of revenue generated is often based on biodiversity, especially on exotic plants and animals. Such nature-based tourism can bring numerous socio-economic benefits to a country, in terms of creating local employment, stimulating local economies, generating foreign exchange, stimulating improvements to local transportation infrastructure, and creating recreational facilities. Positive effects on the environment are often derived from these socio-economic benefits. Appropriate management structures, as well as adequate physical infrastructure and facilities, for tourists are however required to ensure that tourism enhances rather than detracts from biodiversity, and that carrying capacity for tourists is assessed relative to the management objectives to the area. In many parts of the world, the conflict between conservation objectives and the needs of local people increasingly involves tourism as well. How to ensure that local communities earn an appropriate share of the profits from tourism is already a major issue.

29. Local communities may benefit from conservation measures when appropriate investments are made in managing the resources at sustainable levels. For example, the exploitation of forests for timber and other forest products, using appropriate techniques, can be done without endangering the integrity of the ecosystem. While plantations will provide an increasing proportion of the world's timber needs, harvesting from naturally growing forests will continue, as they are still an important social and economic force in many countries. If properly managed, such forests can also make an important contribution to conserving biodiversity. FAO, IUCN, MAB/UNESCO and others have prepared guidelines on sustainable forestry promoting the conservation of biodiversity which invariably involve leaving some forested areas as sources of seeds and other genetic material. Managing primary forests together with protected areas can lead to benefits for both forestry and local people (See Forest document A/Conf.151/PC/64).

30. Many critical habitats in the coastal zone also need protection. In addition to shoreline protection and sustainable harvesting of construction materials, such areas can be especially important as fish breeding grounds (particularly when the surrounding waters are over-fished). Virtually all wetland habitats are important not only for migratory birds, but also for conserving the biodiversity of fisheries, and protecting inland floodplains which are often affected by development projects. Some natural areas, notably wetlands near urban centers, are effective natural sewage treatment centers. For example, Calcutta's sewage has been naturally purified in the 4,000 hectare "Salt Lakes" marshlands east of the city for over 50 years, providing employment for 20,000 fishermen and reducing coliform bacteria levels very significantly. The Salt Lakes therefore make an extremely important economic contribution to the people of Calcutta, and similar functions are served by numerous wetlands through the world. Investing in the maintenance of such systems can often make more economic sense than developing expensive new sewage treatment plants.

31. In industrialized countries the retail value of plant-derived drugs was estimated at $US 43 billion in 1985. It is estimated that the market in developed countries could reach $US 47 million by the year 2000, and this is with only 10 per cent of all plant species examined for their potential medicinal value. 9/ 10/. Today, with advances in plant biotechnology and the availability of new and accurate screening tools, interest in plants, and animals, as a source of raw materials for developing new medicinal products is expanding. The wide diversity of biological resources has made possible the improvement of health through the advancement of the pharmaceutical industry. About 40 per cent of all prescription drugs in industrialized countries are derived from biological resources or synthesized based on chemical make-up of biological resources. Fubocurarine, which is used as a muscle-relaxant during surgery, is based on curare, a plant-derived substance which South American Indians have been using for many years as poison for their blowpipe darts. Didemnin, a drug used against a wide range of viruses, is derived from sea squirts. Additionally, more than 500 marine organisms yield chemicals with anti-cancer potential. 11/ The extinction of biological resources means the loss of a whole pharmacopoeia of unknown size and value to humankind.

32. Indigenous peoples have traditionally used ecological systems and the diversity within to meet their own needs. However their practices have been more compatible with diverse ecosystems and landscapes as they manage crops and animals as mixed systems, as opposed to monocultural practices. Also pest management is usually biological. Indigenous people also modify ecosystems through the widespread use of fire, as a way to return nutrients to the soil and provide more light to crops. Animal husbandry methods use land more efficiently as a wider variety of animals are let to forage over the same area of land.

33. Women and children play an important role in the conservation of biodiversity. They are characteristically the gender and the age group that tend to agricultural activities in most developing countries. Women harvest food, collect fodder, feed the animals, prepare the medicines from wild plants and animals, as well as playing an important part in passing information down to the children. The degradation of ecosystems and landscapes therefore has major impacts on women and children, particularly when they have to move over larger areas in search of food and firewood. In many cases, these distances can exceed 15 kilometers (10 miles) per day. 12/

34. New developments in biology are allowing geneticists to introduce genes into crops from totally unrelated organisms. This increases the palette available to the breeder. It also attaches potential value to genes of wild species which in the pat were not useful. Fermentation is a another example of a very old technology which has been used for centuries, being revolutionized by the new biological knowledge, and making use of a new range of biodiversity. These new industries have a strong stake in the conservation of biodiversity. For example, the science of seed storage is fast evolving, using techniques for the ultra-drying of seeds, which may allow seeds of many species to remain viable under minimal storage conditions for long periods. The maintenance of a wide array of biodiversity and a wide genetic base is therefore fundamental to the future of biotechnology and sustainable development.

35. Biotechnology can bring certain objectives within reach that would otherwise be difficult, impractical, or impossible to achieve. Recent advances in biotechnology make it possible not only to map biodiversity, but also to conserve the resources and even to modify them to withstand adverse conditions such as ecological and environmental changes. There is a great need to support biotechnology research and development, particularly in developing countries, to enhance their ability to adapt, develop, and apply the technology to the conservation of biological resources. Technology transfer is an important element in the process of acquisition of biotechnology by developing countries. Efforts should be made to devise strategies for international cooperation in increasing human resources development in biotechnology, including supporting existing centres such as the International Centre for Genetic Engineering and Biotechnology.

INTEGRATING BIODIVERSITY INTO POLICY-MAKING

36. For biological and genetic resources to be maintained, understood and utilized at sustainable levels and equitably, policies and investments concerning them need to be planned in operational terms. Appropriate biodiversity considerations need to be incorporated into development policies, planning procedures and project formulation so that they become a central feature of policy-making at all levels. The main mechanisms by which biodiversity considerations can be integrated into the development process include land use planning, marine and coastal zone planning, forest management plans, and environmental impact assessment. Planners and policy makers, central and local government supported by the local community, as well as from national or international organizations, have pivotal roles in incorporating goals and means for biodiversity conservation into their efforts.

37. At the international level, the most notable activities to address the misuse of biological and genetic resources relate to the current negotiations on a biodiversity convention, which build on a number of relevant agreements, conventions, and planning mechanisms that have been adopted during the past several decades. These include the FAO Commission on Plant Genetic Resources, the International Undertaking on Plant Genetic Resources, the Tropical Forestry Action Plan, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar), the Convention Concerning the Protection of the World Cultural and Natural Heritage, and the Convention on the Conservation of Migratory Species of Wild Animals. At the national level, governments are taking actions to end subsidies promoting the loss of valuable resources, reform policies that result in the misuse of resources, and to stimulate national technical capacity to increase local benefits from biodiversity and genetic resources.

38. All countries, however, face formidable obstacles in reforming policies because of the strong vested interest in maintaining the status quo held by sectors that benefit from the short-term exploitation of resources. Because of these obstacles, the few positive changes in resource management policies are as yet having little impact on overall trends. At the local level, communities are taking steps independently or with government support to secure the resources that they depend on locally for their livelihoods. Such

activities include establishing community seed-banks, forming organizations to promote the conservation of indigenous crops, participating actively in planning and policy dialogues within the country, and in some cases even actively defending resources necessary for their livelihoods.

39. Development and conservation of biodiversity must proceed together, as they enhance and strengthen each other. It is unrealistic to expect that no loss of biodiversity will occur. It is crucial that policies be developed and implemented with the full knowledge of the value of the biodiversity that is lost. Where policy-makers are well-informed on the full costs and benefits of different policy choices, it is more likely that biodiversity conservation will be incorporated as an objective. Where the wider public is informed of the consequences for biodiversity of alternative policy choices, it too can play a more active and informed role in influencing these choices.

40. Many existing development policies and incentives tend to be perverse or inadequate towards biodiversity, and planning procedures tend to fragment biodiversity by traditional sectors. Policies for the conservation and development require well-targeted information. Unfortunately, information about the characteristics and extent of species, genes and habitats is scarce and typically offered in a form which is of little use for planners and policy-makers, having been developed by scientists for scientific purposes. In addition, the ethical, cultural and market values of biological resources are little understood and are therefore undervalued. In recent years, the increasing tendency to privatize plant breeding linked to breeders' and patent rights in industrialized countries has highlighted the need for equity in the relative recognition and reward accorded to the formal and informal innovation systems.

41. All these problems clearly need to be tackled if the conservation of biodiversity can truly come to be regarded as one of the leading goals of international policy-making as well as national development, and as an investment opportunity, rather than as a burden.

KEY SCIENTIFIC AND TECHNICAL LINKAGES

42. Forests: Forests and woodlands, especially those in the moist and seasonal tropics and in some parts of the sub-tropics but also temperate arboreal forests, contain a wealth of species of actual or potential socio-economic importance at the global, national and local levels, including wild relatives of important crop species. Approximately 40 per cent of the total forested land area lies within the tropics, providing some of the most complex ecosystems in the world in terms of species composition and interactions, structural variability and biological and ecological functions. These forests are being lost at a rate of about 17 million hectares per year (an area half the size of Japan), often because of the extension of the cultivated area. This clearly poses a serious threat to ecological stability, to the sustainability of development, and to human development and welfare.

43. Climate Change: Biodiversity is likely to play a key role as the climate changes. When the environment changes as a result of climate or other physical alterations, organisms of low relevance in ecosystems often evolve

into major roles. An example is the evolution of mammals following the demise of the dinosaurs. The greater the existing biodiversity, the better the biota can adapt to new environmental circumstances. With the general level of uncertainty which surrounds the issue of climate change, it is important that a minimum level of biodiversity be maintained. Especially important is maintaining biodiversity in coastal areas within 60 kilometers of the coast, which will be particularly impacted if the sea level rises as a result of global warming. In these areas, where more than 60 per cent of the human population now live, biodiversity has been reduced very drastically through draining of wetlands, destruction of mangroves, and other coastal ecosystems. The loss of such biological resources affects not only the ecological integrity of coastal areas, but also the security of the coastal communities.

44. The way in which biological resources adapt to any change is also likely to provide critical indicator information about the kind of changes taking place. More information is needed on which genetic resources are likely to be lost and needed as the climate changes, as well as on those parts of the planet in which food crops will be vulnerable to changes. It will also be necessary to monitor any changes in distribution patterns of species to ensure, for example, that protected areas are still in the most appropriate places. Furthermore, little information exists about climatic factors within natural areas of vegetation or crop systems. For these reasons and more, it will be important that biodiversity concerns are accorded the most careful consideration in the intergovernmental negotiating process on a Climate Change Convention.

45. Biotechnology: One of the main problems associated with reforestation in Africa concerns the problems of unsuitable seedlings. The use of biotechnology to provide more suitable seedlings offers the promise of much more successful planting operations. Recent advances in biotechnology research and development are now being used to speed the development and use of germ plasm in modern crop varieties and to develop new varieties. Biotechnology therefore offers new possibilities for increasing the production of food, medicines, energy, specialized chemicals and other raw materials, and for improving environmental management. This reinforces the need to maintain the richest possible pool of genes. As the field of biotechnology develops, the scope of future germ plasm needs will be far greater than now. The high stake which the biotechnology industry holds in the conservation of biodiversity should not be under-estimated: the projected loss of diversity could seriously endanger the genetic base required for the continued improvement and maintenance of currently utilized species and deprive humankind of the potential to develop new ones.

46. Oceans: The oceans, including enclosed and semi-enclosed seas, like terrestrial systems, contain a rich diversity of biological and genetic resources. They provide the basis for fisheries, and offer great potential in the provision of pharmaceutical products and new food species. Coral reefs and other coastal ecosystems, where most species are located, are of particular importance for biodiversity, providing habitats for feeding, reproduction, shelter and nursery grounds for juvenile species. The coral reefs in particular are likely to serve as indicators of climate change, pointing up threats to other species. Marine biodiversity also plays a

valuable role in small island states, coastal states, and other economies in which fisheries provide an important economic basis. The application of appropriate marine biotechnologies has an important role to play here, ranging from the types of hooks and nets used to catch fish to the radar and satellite technology used to locate schools of fish and the development of techniques to promote sustainable fish yields, as well as to avoid killing non-target fish species and destroying marine ecosystems.

IN SITU AND EX SITU CONSERVATION

47. Ex situ conservation, i.e. the maintenance of living organisms outside their natural habitats, can be achieved by means of germ plasm banks (collections of seeds, tissues kept in vitro, etc.) and living collections (zoos, botanical gardens, arboreta, field genebanks, etc.). It has two unique attributes; it allows for the accumulation of knowledge on a particular group of individuals, and it permits immediate access. The first attribute helps make re-introduction possible and helps give a better cost estimate for particular biota. The second attribute is the basis of most plant introduction efforts in forestry, horticulture, etcetera. Germplasm introduction from ex situ facilities can be a tool for rapid agricultural progress. If wrongly used, it can be very harmful to native species (e.g. the introduction of the prickly pear in Australia).

48. In situ conservation concerns the maintenance of living organisms in the natural habitats and within the animal/plant community of which they form a part with little or no human intervention in the ways these organisms grow, reproduce and die. There is growing awareness that conservation of the earth's biota will be costly, whether by in situ or ex situ methods. It is important, therefore, that the most effective method or combination of methods should be chosen in each case and that experts in all aspects of conservation should work together in a fully integrated effort.

49. Ex situ methods can be considered a priority for the most endangered species. Once populations reach the point of extinction (e.g. the Californian condor or the Arabian oryx), ex situ methods may offer the only way to re-establish them. During the process of multiplication of species ex situ, very useful information can be obtained about the requirements for making successful future reintroductions into the wild. The reintroduction into China of the Père David Deer from the United Kingdom is only one successful example of this. Likewise, crop genebanks, having saved a particularly useful variety now extinct in the traditional agricultural system where it originated, can re-distribute it to breeders and farmers who require it.

50. Botanical gardens, herbaria, zoological museums, and marine stations, because of their high standards and long involvement in the study of species, play an invaluable role in the task of naming and classifying plants and animals and in the support of ex situ and in situ conservation. Their continued collaboration will be essential in biodiversity surveys; to document the resources of tropical and temperate regions, both terrestrial and aquatic; to document the resources of theses regions in terms of numbers of species and their distribution; to determine which species are most at risk; and to

indicate conservation priorities. These institutions maintain reference collections on which classification systems are based, which can now be used not only for naming but also for monitoring some aspects of genetic erosion.

51. New techniques allow extraction and typing of the DNA of dead specimens of organisms that are now extinct. It may be possible in the future to re-insert some of that DNA into living organisms. Museums also play an important role in public education and in training biologists and conservation specialists. The financial support however for museums, herbaria, botanical gardens, and marine biological stations has decreased recently, forcing them to reduce their technical and scientific staffs, and raising doubts about their ability to remain viable and assist in the study and conservation of biodiversity. The importance of their scientific and societal contributions have not been always recognized and a review of their resources is long overdue.

52. At the research level also, a much fuller integration between the different aspects of conservation seems appropriate. Periodic assessment of the speed of genetic erosion or loss of species, together with the status of knowledge about target species, and a careful assessment of resources available for conservation (both technical and social), are among the key elements for decision-making which are the common to ex situ and in situ conservation. Only by coordinating activities and sharing information can conservation scientists and managers develop the most appropriate and cost-effective strategies.

EDUCATION, TRAINING, AND KNOWLEDGE

53. There is a need for more education on the importance of biodiversity for human welfare, in training of specialized personnel, and in research to increase our knowledge about the role that biodiversity plays in the maintenance and evolution of species and ecosystems.

54. There is an acute lack of training opportunities. This problem is most acute in the developing countries. Over two-thirds of the world's biodiversity is located in developing countries, together with three quarters of the world's population, but only 6 per cent of the wor 's engineers and scientists. There is a great need therefore to build up the ability of many of these countries to train specialized personnel in order to expand their capacity to conserve their biodiversity and use their biological resources wisely.

55. Job opportunities in fields involved with the study, conservation, and management of biodiversity, are few and relatively poorly paid worldwide. Often trained personnel occupy positions which are not directly related to the study, conservation, or use of biological resources. The fundamental importance of biodiversity in the development process, and its role in ecosystem function, needs to be fully recognized at all levels of policy making. For this purpose, it is necessary that the resources be provided to create or strengthen institutions concerned with biodiversity.

56. There is a lack of specialists who can advance and pass on their knowledge of biodiversity, how it functions and how best to conserve it. The case of taxonomists is especially critical; everywhere, the number of taxonomists capable of identifying plants, animals and micro-organisms that make up the biodiversity of the planet has sharply dropped in recent years. Universities no longer teach taxonomy specialists and resources are lacking to create posts for them. Furthermore, the science of conservation biology, which emphasizes the genetic aspects, is as yet in its infancy and is rarely applied. Work in this field has indicated, for example, that most protected areas in the world are in fact too small to maintain a viable, adequately diverse population of their larger mammals, which means that they will not survive in these areas in the longer term. There is therefore a need to build up the numbers of specialists who can advance this knowledge and propose practical solutions.

57. Ex situ conservation efforts are also far too limited with inadequate numbers of trained personnel. Many zoos and botanical gardens for example do not yet participate in the global efforts for captive breeding or propagation of endangered wild species or the conservation of endemic species. Links with in situ conservation efforts are also inadequate. Furthermore there is a great need to increase the numbers of genebanks, especially in developing countries, as well as conservatories for maintaining stocks of varieties of agricultural plants and traditional breeds of livestock.

58. There are also insufficient trained personnel to document and pass down to future generations traditionally-acquired knowledge and skills for conserving and using resources. Such knowledge and skills have very often been based on centuries of trial and error and offer great potential for truly sustainable use. The situation is compounded by the fact that many traditional societies and indigenous cultures are rapidly disappearing, in both the north and the south. Biodiversity is inextricably linked to indigenous cultural values. Biodiversity depletion means cultural depletion and poverty. For many indigenous peoples the concept of poverty includes not only the lack of goods, services, and income, but also the loss of opportunities to relate with nature in its great diversity. In practical terms, an effort needs to be made to rescue not only the traditional knowledge which has been accumulated over the centuries, but the knowledge of farmers, ranchers, and non-professional naturalists all over the world.

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